THE SECULAR INEQUALITIES IN TERRESTRIAL CLIMATES DEPENDING ON THE PERIHELION LONGITUDE AND ECCENTRICITY OF THE EARTH'S ORBIT

A PAPER on this subject, by the Rev. Dr. Haughton of Trinity College, Dublin, was read before the Royal Society on February 24 last. Dr. Haughton shows that the two inequalities in question depend upon terrestrial radiation only, and in no way upon sun-heat.

Having noticed that the hottest and coldest time of day *follows* noon and midnight by an interval often considerable; and in like manner that the hottest and coldest days in the year *follow* midsummer and midwinter[1] by an interval often of many days; Dr. Haughton saw in these facts a close analogy with the diurnal tides, which follow the sun or moon's meridian passage by an interval of some hours.

Dr. Haughton was thus led to solve the differential equation on which the problem depends, by assuming an expression similar to those so well known and so long employed in the mathematical discussion of the tides of the ocean.

The result fully justified the assumption of expressions similar to diurnal tidal expressions, for when the differential equation is integrated for a day and summed for a year, all the periodic terms disappear, and nothing is left but terms depending on the perihelion longitude and eccentricity, which represent the exact mathematical expression of the two inequalities first noticed by Adhémar and Croll.

The final result takes the form—

Mean annual temperature

$$= k\left((\Theta_0 + a) \pm (\alpha_1 \cos \varpi + \beta_1 \sin \varpi)e\right) \quad . \quad . \quad (1)$$

where

k, = Constant,
Θ_0, = Mean annual temperature of place,
a, = "Control"[2] temperature of atmosphere at place.

α_1 and β_1 are defined by the following equations:—

$2\sqrt{\alpha_1^2 + \beta_1^2}$ = Range of annual temperature.

$\frac{\beta_1}{\alpha_1}$ = Tangent of the arc which represents the retardation of the maximum and minimum temperature.

ϖ = Longitude of earth's perihelion.
e = Eccentricity of earth's orbit.

Using Ferrel's temperature tables, Dr. Haughton finds the following maximum secular ranges of mean annual temperature:—

Maximum Secular Range

Latitude.	Northern hemisphere.	Southern hemisphere.
°	°	°
0	0·185 F.	0·185 F.
10	0·375 ,,	0·585 ,,
20	1·100 ,,	0·875 ,,
30	2·065 ,,	1·110 ,,
40	2·750 ,,	0·985 ,,
50	3·685 ,,	0·710 ,,
60	4·610 ,,	0·540 ,,
70	4·985 ,,	—
80	4·925 ,,	—

This table shows that the average maximum effect of the astronomical causes involved in perihelion longitude and eccentricity never can exceed 5° F. in the northern hemisphere, and barely exceeds 1° F. in the southern. At particular localities, where there is a great range of annual temperature, the effect may be somewhat greater. For example, at North Grinnel Land the range becomes 6°·5 F. It will be seen how little benefit this would confer upon that locality, when it is remembered that the present mean annual temperature of North Grinnell Land is 2°·42 F. *below* zero, and that by the secular range it could be raised to 0°·21 F. *above* zero, or depressed to 6°·29 *below* zero.

At Discovery Harbour Tertiary plant beds were found by the Arctic explorers, which indicate a *July temperature greater than 63°·7 F.*; the present July temperature of Discovery Harbour is 37°·2 F. above zero, or *only five degrees above the freezing point of water*. How is this remarkable change in climate to be accounted for? Geologists cannot much longer evade answering such questions as these.

[1] In the British Islands January 15 is reckoned the time of maximum cold, which is twenty-four days after midwinter.

[2] By this is meant the temperature of the upper layers of the atmosphere of place, which controls the radiation; this temperature varies with the latitude, and is probably always below zero Fahrenheit.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Cambridge Museums are every year the scene of a large increase of work, new departments being continually added, even under the present conditions of impecuniosity. The annual reports recently issued on the condition and progress of all the departments testify to much excellent work. The death of Prof. Miller, who for forty-nine years occupied the Chair of Mineralogy, has brought a valuable bequest to the museum he presided over, in the shape of 300 volumes of books and many specimens and scientific instruments, including his famous goniometer and the physical apparatus, balances, thermometers, and barometers employed by him in his investigations for the restoration of the standards of weight. Prof. Lewis, who has succeeded to the Chair of Mineralogy, ably assisted by Mr. Solly, is cataloguing the museum, and already half the work is accomplished. Valuable specimens besides Prof. Miller's bequest have been added to the museum by purchase as well as by donation, including a small case of minerals belonging to the late Dr. E. D. Clarke, given by the Rev. B. S. Clarke, Boxted, Colchester. Prof. Lord Rayleigh's Apparatus Fund has reached 202*l.*, including 50*l.* from himself, which has been spent partly upon instruments required to be multiplied, in consequence of the increased number of students; but the additions during the year also comprise a large electro-magnet with heavy glass and nicol; a 2½-inch achromatic telescope; Joule's apparatus for investigating the maximum density of water; telephones and various optical apparatus, including new double refractive apparatus for combining prismatic colours. Many important pieces of apparatus have been made for the Cavendish Laboratory in Prof. Stuart's laboratory. Professors Liveing and Dewar report that with the 200*l.* alloted to them they have purchased several pieces of apparatus permanently useful in a variety of investigations. Prof. Stuart's department (mechanism) has progressed very considerably during the year. The apparatus, machines, tools, and materials in connection with the department have been recently valued at over 1500*l.*, of which only about 250*l.* is University property, the rest having been provided by the private enterprise of Prof. Stuart. In the Geological Museum, despite the want of suitable workrooms, Mr. Tawney has succeeded in arranging the petrological collection. Mr. Keeping reports the addition of many important fossil specimens both from England and America. Prof. Humphry reports further additions to the rich collection of human skulls under his charge. Mr. J. W. Clark, Superintendent of the Museum of Zoology and Comparative Anatomy, calls special attention to the beautiful coloured drawings of animals that cannot be preserved in spirit, or are too small to be seen without a microscope, added by Prof. A. C. Haddon, late Curator in Zoology. His successor, Mr. A. H. Cooke, Fellow of King's College, has commenced the work of determining and cataloguing the Woodward and Hepburn collections of shells. Mr. Clark has added a series of preparations showing the structure of the manatee, from a specimen presented by the Directors of the Brighton Aquarium. The very fine skeleton of the musk-ox brought home by the North German Polar Expedition of 1872 has been purchased. The skeleton of *Ceratodus Forsteri*, from the specimen presented by Prof. Liversidge, has been prepared in the museum. Many additions have also been made to the reptilian, ornithological, and other series. Dr. Michael Foster notes that his classes for histological work have become so large that a new bench, less convenient as to light, has been added. The numbers attending his courses are between sixty and seventy men and twenty women for the elementary classes, and fifteen men for the advanced classes. He remarks that his students would profit more if not so much harassed by striving to attend too great a number of lectures and courses. Prof. Babington records a large amount of herbarium work, including the naming of Gardner's collection of Brazilian plants, numbering 5000 specimens, presented by the professor. He has also obtained, at a very moderate cost, the entire collection of the late M. Gaston Genevier of Nantes, consisting of about 7000 species from France, Spain, Algeria, Asia Minor, &c., and all the typical specimens—over 500 in number—of the Rubi, described in his monograph of the genus Rubus. A proposal has been made by the Cambridge Philosophical Society to make their large and useful scientific library available for scientific students generally, and to allow it to be the nucleus of a much-needed library of science in the new museums, if the University will provide the salary of a librarian

for it. It is desired that this library shall be placed in a room vacated by Dr. Michael Foster's classes, and formed by the amalgamation of two old classrooms.

THE VICTORIA UNIVERSITY.—The Preliminary Examinations for the year 1881 will be held at the Owens College on June 20 and following days, and on October 5 and following days. Regulations:—1. Candidates for these examinations are required to present certificates of matriculation in the University. 2. The days fixed for matriculation are June 13 and 14, between the hours of two and four p.m., and October 1 and 3. 3. Students, on presenting themselves for matriculation, are required to furnish to the Registrar of the University certificates of admission as students of one of the colleges of the University, to pay a fee of 2*l.*, and to sign an undertaking to obey the regulations of the University. 4. The October Preliminary Examination is open only to students who have matriculated since the Preliminary Examination held in the previous June, or who failed in this examination, or were prevented attending it by reasons satisfactory to the General Board of Studies. Candidates are requested to communicate with the Registrar, Prof. Adamson, who will supply them with the detailed syllabus of subjects, regulations, and time-table for the examination.

ROYAL UNIVERSITY OF IRELAND.—The copy of the scheme for the organisation of the University as adopted by the Senate has now been laid, pursuant to Act of Parliament, before the House of Commons, and it has been, by order of that House, printed. It gives full details of the degrees to be granted, which are in Arts a Bachelor, a Master, and a Doctor of Literature degree; in Science a Doctor's degree; in Engineering a Bachelor and a Doctor's degree; in Law, Music, and in Medicine the same; in surgery a Master's degree, with a special diploma in Obstetrics and in Sanitary Science. All these degrees are open to persons of either sex. The examinations for women shall be held apart from those for men, but on the same days. Candidates for any degree must have passed the Matriculation Examination, which will be held not only in Dublin but at certain local centres. The examination will be held in the subjects of Latin, English, Elementary Mathematics, Experimental Physics, and in any one of the following languages: Arabic, Celtic, French, German, Greek, Hebrew, Italian, Sanskrit, or Spanish. Candidates must also pass a first University Examination, to which they will only be admitted after the lapse of one academical year from matriculation, the subjects for this being a more advanced course of that fixed on for matriculation. One year after this is passed the student in Arts may proceed to his second University examination, in which he will have his choice of a great variety of subjects, but Latin, Greek, and English on the one hand, or Mathematics on the other, are compulsory. At this stage of his career the student may select Biology, including Physiology, Botany, and Zoology, or Geology, and after the expiration of one more year he can proceed to his B.A. examination, for which he will be permitted to select either the Classics or Mathematics, with the selection of one other of a long list of subjects given. For the M.A. examination the candidate must be a B.A. of one year's standing at the least, and he may answer in any one of a selected group of subjects. The regulations for the degrees of Doctor of Literature and Doctor of Science are not yet matured. Twelve scholarships of 50*l.* each are to be offered each year for competition, four in Classics, four in Mathematics, and four in Modern Literature. Exhibitions varying from 100*l.* to 15*l.* will be given to Honour Men. There are to be forty-eight Fellows. The salary of a Fellow, if he be not also a Fellow or Professor of some other University or College attached to a University endowed with public money, shall be 400*l.* a year. If he be such, then he shall only receive so much as will bring his salary up to 400*l.* a year. These Fellows shall constitute a Board of Examiners. There shall be also fourteen junior Fellows, their salary to be 200*l.* a year. No Fellow or Professor of any other College or University is eligible, and the candidates must be Graduates of the Royal University of four years standing. All Fellowships are tenable for seven years. Thus if a senior Fellow be elected from an already endowed College, the chances are that while he will have to do his full share of the work, he will receive only as much salary as will bring his total emoluments to 400*l.* Thus a Professor of one of the Queen's Colleges (Belfast or Cork) if elected would only receive 5*l.* or 10*l.* a year, but if a Professor from the Catholic College in Dublin were elected, as it is not endowed, he could receive a full 400*l.* a year, and yet his duties would be —so far as the Royal University is concerned—the same as his colleague from the endowed College, who would receive almost no salary at all. Thus a scheme for endowing Colleges through the resources of the Royal University has been at last successfully carried out. The subjects and books for the various examinations appear to be most judiciously selected, and in many respects might teach a lesson to our older Universities. The Senate close their scheme by a request that provision may be made for securing for the University a proper Senate Hall, Examination Rooms, a Library, &c., and urge that these should be all built within the area of the City of Dublin.

ETON.—Mr. G. C. Bourne of Eton College has been elected to a Natural Science Exhibition of 50*l.* a year for four years at New College, Oxford, for proficiency in Biology. Mr. Bourne is one of the foremost athletes of his school, having rowed in the Eton crew at Henley Regatta for the last three years, as he will again in a few weeks' time. For the past two years he has filled the exalted but responsible post of "captain of the boats," but has nevertheless found time to devote himself successfully to his favourite study, and has gained new honours for his school in a field hitherto untrodden by Etonians.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, April.—The wearing power of steel rails in relation to their chemical composition and physical properties (continued), by Dr. Dudley.—Experiments on the strength and stiffness of small spruce beams, by Mr. Kidder.—Observations on the water-supply of Philadelphia, by Mr. Haines.—A fourth state of matter, by Mr. Outerbridge, jun.—The moon of Earth and Jupiter, by Dr. Chase.

Bulletin de l'Academie Royale des Sciences de Belgique, No. 2.—Note on the determination of the longitude of Karema, by Capt. Cambier.—New data on the non-existence of pentathionic acid, by M. Spring.—On a new fossil fish of the environs of Brussels and on certain enigmatic bodies of the crag of Antwerp, by M. van Beneden.—On phosphate-beds in Belgium (third note), by M. Petermann.—On the theory of polars, by M. Le Paige.—On a new form of reddish frog from the south-east of France (*Rana fusca Honnorati*), by M. Héron Roger.—Study on the hypophysis of Ascidians and the neighbouring organs, by M. Julin.

Bulletin de l'Academie Imperiale des Sciences de St. Petersbourg, t. xxvii. No. 2.—Development of the absolute perturbations of a comet, by O. Backlund.—Champignons recently collected in Mongolia and Northern China, by C. Kulchbrenner and F. de Thümen.—Observations of Jupiter's spots, by M. Kortazzi.—On the oxidation products of erythrite, by S. Przybytek.—The money of the Ileks, ancient Khans of Turkestan, by B. Dorn.—Remarks on the group of the Pteroclides, by M. Bogdanoud.—Relations between isobars and isanomalies of temperature, by H. Wild.—Influence of pressure on the electric resistance of metallic wires, by O. Chwolson.—The Russian species of humble-bees in the collection of the Academy, by F. Monawitz.—On the value of errors depending on the retardation or prematurity of impulsions in Weber's methods for measuring instantaneous electric currents, by O. Chwolson.

Archives des Sciences Physiques et Naturelles, No. 4, April 14.—Study on the chemical composition of albuminoid substances, by Dr. Danilewsky.—Automatic methanometer, or automatic analyser of fire-damp, by M. Monnier.—Researches on vegetation, by Prof. Westmann.—Distillation and rectification of spirits by the rational use of low temperatures, by M. Pictet.—On phyllotaxy (continued), by M. de Candolle.

Rivista Scientifico-Industriale, No. 7, April 15.—Second reply in defence of the true theory of the siphon, by Prof. Marangoni.—Determination of the specific gravity of solids soluble in all liquids, by Dr. del Lupo.—Relation of the specific gravity and the pressure of saturated steam, by Prof. Ciccone.

THE last number of the Russian *Journal* of the Chemical and Physical Society (vol. xiii. fasc. 4) contains the following papers:—On the rate of chemical reactions, by M. N. Kayander.—On the influence of chemical structure on the refrigerating power of organic bodies, by M. J. Kanonnikoff.—On the laws of double decompositions, by M. A. Potilitzin.—On the chemical value of the constituents of alcohols, by Prof. Mensbutkin.—On ice under "critical pressure," by Prof. Boutleroff.—On electricity of con-